

General Psychology

Biology & Behavior: The Brain

These are general notes designed to assist students who are regularly attending class and reading assigned material: they are supplemental rather than exhaustive and reflect general concepts.

I. THE NERVOUS SYSTEM: A BASIC BLUEPRINT (LEARNING OBJECTIVES 1,2,3,4)

A. Neuropsychologists - search for the basis of behavior in the brain

B. The central nervous system

1. Functions - receives, processes, interprets, and stores incoming information; sends out messages to muscles, glands, and internal organs
2. Parts - brains and spinal cord (an extension of the brain)

C. The peripheral nervous system - nervous system outside brain and spinal cord

1. Functions
 - a. Sensory nerves - bring input from skin, muscles, and organs
 - b. Motor nerves - carry output to muscles, glands, and organs
2. Divisions
 - a. Somatic nervous system
 - (1) Nerves connected to sensory receptors
 - (2) Nerves connected to skeletal muscles - voluntary action
 - b. Autonomic nervous system - works automatically
 - (1) Functions - regulates blood vessels, glands, and organs
 - (2) Biofeedback - helps people control autonomic responses
 - (3) Divisions
 - (a) Sympathetic - mobilizes the body for action
 - (b) Parasympathetic - enables body to conserve and store energy

II. COMMUNICATION IN THE NERVOUS SYSTEM: THE NUTS AND BOLTS (Learning Objectives 5,6,7)

A. Components of the nervous system

1. Neurons - cells that communicate to, from, or within the CNS
 - Glial cells - hold neurons in place, nourish, and insulate neurons

B. The structure of the neuron

1. Dendrites - receive messages away from cell body to other neurons
2. Cell body - keeps the neuron alive, determines whether to fire
3. Axon - transmit messages away from cell body to other neurons
 - a. End in branches or axon terminals
 - b. Many axons insulated by fatty material or myelin sheath
 - c. Bundles of axons in the peripheral nervous system form nerves

C. How neurons communicate

1. Synapse = axon terminal + synaptic cleft (small space between one axon and next dendrite) + receiving dendrite

- a. Billions of neurons may connect at a synapse
- b. Synaptic connections continue to be formed throughout life
- 2. How neurons communicate
 - a. Wave of electric voltage, called action potential, moves down axon to end of axon terminal, called synaptic end bulb
 - b. Action potentials travel more rapidly in myelinated axons than in unmyelinated axons
 - c. Synaptic end bulb releases chemical neurotransmitters (transmitters) which have been stored in synaptic vesicles (sacs in the end bulb)
 - d. Transmitters cross the synaptic cleft and briefly lock onto receptor sites on the receiving dendrites
 - e. They can increase or decrease the likelihood that the receiving neuron will generate an action potential
 - f. Receiving neuron averages the excitatory and inhibitory incoming messages to determine if it reaches firing threshold
 - g. Neurons either fire or do not fire (all or none); the strength of firing does not vary

D. Chemical messengers in the nervous system

- 1. Neurotransmitters: Versatile couriers
 - a. Dozens have been identified, more are being found
 - b. Each binds only to certain types of receptor sites
 - c. Better understood neurotransmitters and some of their effects
 - (1) Serotonin - sleep, mood, and more
 - (2) Dopamine - movement, learning, memory, and emotion
 - (3) Acetylcholine - muscle action, memory, and emotion
 - (4) Norepinephrine - heart rate, learning, and memory
 - (5) GABA - major inhibitory neurotransmitter in the brain
 - (6) Glutamate - important excitatory neurotransmitter
 - d. Levels that are too high or too low may produce problems
 - (1) low levels of serotonin and norepinephrine associated with depression
 - (2) elevated levels of serotonin associated with autism
 - (3) abnormal GABA levels associated with sleep and eating disorders and convulsive disorders
 - (4) loss of cells that produce dopamine associated with Parkinson's disease - grafting of dopamine-producing tissue into brain may help Parkinson's patients
 - e. Each neurotransmitter plays many roles and functions overlap
 - f. Cause and effect between neurotransmitters and behavior unclear
- 2. Endorphins: The brain's natural opiates
 - a. Produce effects similar to natural opiates; reduce pain, promote pleasure, as well as other behaviors
 - b. Most act as neuromodulators - influence actions of neurotransmitters
 - c. Work by binding to receptors in brain
 - d. Levels increase during stress or fear response
 - e. Release of endorphins may also be linked to the pleasures of social contact
- 3. Hormones: Long-distance messengers
 - a. Substances produced in one part of the body but affect another
 - b. Originate in endocrine glands that release hormones into the bloodstream, which carries them to other organs and cells

- c. Affected by and affect nervous system functions
- d. Parts of the nervous system and the endocrine system that interact are called the neuroendocrine system
- e. Hormones of particular interest to psychologists
 - (1) Melatonin - secreted by the pineal gland, regulates biological rhythms
 - (2) Adrenal hormones - involved in stress and emotional responses, produced by the adrenal glands which are composed of:
 - (a) Cortex - an outer layer producing cortisol
 - (b) Medulla - inner core which produces epinephrine and norepinephrine
 - (3) Sex hormones - 3 major types; all 3 types occur in both sexes
 - (a) Androgens (i.e. testosterone) - masculinizing, influence sexual arousal in both sexes
 - (b) Estrogens - feminizing, influence menstrual cycle
 - (c) Progesterone - maintenance of uterine lining

III. EAVESDROPPING ON THE BRAIN (Learning Objective 8)

A. Researchers study the brains of those who have experienced disease or injury

B. Lesion method - involves damaging or removing section of brain in animals and then observing the effects

C. Monitoring electrical activity in the brain

- 1. Electroencephalogram (EEG)
 - a. Brain wave recording, not very specific
 - b. Data from EEGs can be made more specific and informative by incorporating computer technology
 - (1) Yields picture of brain activity patterns associated with specific events
 - (2) Computers help to analyze evoked potentials
- 2. Needle electrodes
 - a. Thin wires inserted into the brain to record electrical activity
 - b. Microelectrodes - fine wires that can be inserted into single cells

D. Needle electrodes may also be used to stimulate the brain electronically

E. Positron-Emission Tomography - PET scan

- 1. Records biochemical changes in the brain as they occur
- 2. Utilizes a radioactive glucose-like substance
- 3. Used to diagnose abnormalities or to learn about normal brain activity

F. Magnetic Resonance Imaging (MRI)

- 1. Uses magnetic fields and radio frequencies
- 2. Used for both diagnosing disease and studying function in normal brains

G. Other techniques - include combining EEG and MRI technology

IV. A TOUR THROUGH THE BRAIN (Learning Objective 9)

A. The hindbrain: Vital functions

- 1. Brain stem - located at base of skull; old part of brain
 - a. Medulla - regulates breathing and heart rate; automatic functions
 - b. Pons - involved in sleeping, walking, and dreaming
- 2. Reticular activating system - network of neurons, extends upward and connects with higher brain areas; screens information, responsible for arousal and alertness
- 3. Cerebellum - regulates balance and coordination of movement

B. The midbrain: Important way stations - neural tracts running to and from the upper and lower portions of the brain

C. The forebrain: Emotions, memory, and thought

1. Thalamus - directs incoming sensory messages to higher centers
 - a. Sense of smell is the only sense bypassing the thalamus
 - b. Information about smell goes to the olfactory bulb
2. Hypothalamus - associated with drives, such as hunger, thirst, emotion, sex and reproduction, body temperature, and the autonomic nervous system
3. Pituitary gland - "master gland" governed by hypothalamus
4. Limbic system - loosely interconnected structures involved in emotions
 - a. Amygdale - evaluates sensory information to determine its importance, may be involved in anxiety and depression
 - b. Hippocampus - "gateway to memory," compares sensory feedback with expected feedback
5. Cerebrum - responsible for higher forms of thinking
 - a. Divided into 2 halves or cerebral hemispheres
 - (1) Connected by band of fibers called corpus callosum
 - (2) Right hemisphere in charge of left side of body
 - (3) Left hemisphere in charge of right side of body
 - (4) Lateralization - each hemisphere has somewhat different tasks and talents
 - b. Covered by layer of densely packed cells - cerebral cortex
 - (1) Grayish appearance = gray matter
 - (a) made up of cell bodies of nerve cells
 - (b) "white" matter beneath cortex is formed by myelinated axons
 - (2) Contains 3/4 of all cells in the brain
 - (3) Divided into 4 regions
 - (a) Occipital lobes - contain the visual cortex
 - (b) Parietal lobes - contain somatosensory cortex, that receives information about pressure, pain, touch, and temperature from all over the body
 - (c) Temporal lobes - contain auditory cortex
 - (d) Frontal lobes - contain the motor cortex; responsible for making plans, taking initiative and thinking creatively
 - (4) Associations areas make up large parts of the cerebral cortex
 - (5) Prefrontal association areas may be involved in social judgment, rational decision-making, and the ability to set goals and make and carry out plans
 - (a) Damage to the prefrontal cortex may impair these abilities
 - (b) Case of Phineas Gage illustrates the consequences of damage to the prefrontal cortex
 - (c) Aid in the normal expression of emotions
 - (d) Involved in help us determine the proper order of behaviors and knowing when to stop

V. THE TWO HEMISPHERES OF THE BRAIN (Learning Objective 10)

A. Split brains: A house divided

1. Corpus callosum, which connects the cerebral hemispheres in normal brains, is severed
2. This surgery is performed in animal studies and for some human conditions
3. Effects
 - a. Split-brain patients are able to lead normal lives

- b. Effects on perception and memory are observable under experimental conditions

B. Differentiation of function in normal brains

1. Left hemisphere handles language for nearly all right-handed people and a majority of left-handers
 - a. Broca's area - speech production
 - b. Wernicke's area - meaning and language comprehension
2. Left side more active than right during some logical, symbolic, and sequential tasks, such as math

C. A question of dominance

1. Many researchers believe the left side is dominant because cognitive skills, including rational and analytic abilities, originate here
2. Others point to abilities of the right hemisphere: superior visual-spatial abilities, facial recognition, appreciation of art and music; some researchers claim it is holistic and intuitive
3. In real life, the 2 hemispheres cooperate automatically in most activities

VI. TWO STUBBORN ISSUES IN BRAIN RESEARCH (Learning Objectives 11,12,13)

A. How specialized are separate brain parts?

1. Localization of function - theory that reflects the belief that different brain parts perform different jobs
 - a. Continues to be the guiding principle in brain theories
 - b. Considerable research support
2. Minority view - information is distributed across large areas of the brain - holistic theories
 - a. One approach says that the average pattern of cell activity throughout the brain is important - the brain works like an orchestra
 - b. Another approach compares brain functioning to holography
 - c. These approaches can explain the brain's plasticity and flexibility
3. Most likely a combination of both is true - parts of an event are localized, parts are distributed

B. Are there "his" and "her" brains?

1. Efforts to identify male-female differences have reflected biases of the times
2. Two questions must be asked:
 - a. Are male and female brains physically different?
 - (1) Sex differences have been found in animal brains
 - (2) Human sex differences more elusive
 - (a) Many changing findings, many contradictory findings
 - (b) Many different conclusions drawn
 - b. Both right and left hemisphere areas are activated during a rhyming task in women; only left hemisphere areas are activated in men - evidence of possible sex difference in lateralization
 - c. If there are brain differences, what do they mean for the behavior of men and women in real life?
 - (1) Biological differences may produce behavioral differences
 - (2) Many sex differences that are discussed are stereotypes
 - (3) Overlap in behavior between the sexes is greater than the differences between them

C. Considerations when thinking about the brain

1. Brain organization - the proportion of brain cells found in any part of the brain varies from person to person
2. Experience constantly influences the brain

- a. Affects the brain circuitry
- b. Affects brain organization

Think About It: Puzzles of Psychology

Where is Your self?

Where in the brain is the self and how can the self be its own observer?

Taking Psychology With You

Food for Thought: Diet and Neurotransmitters

Diet may influence mood, performance, and mental health by affecting neurotransmitters. However, the effects of nutrients are subtle and depend on many factors, such as age, time of day, circumstances, etc.